

Melting of the primitive Mercurian mantle, insights into the origin of its surface composition

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Recent findings of the MESSENGER mission on Mercury have brought new evidence for its reducing nature, widespread volcanism and surface compositional heterogeneity [1-3]. MESSENGER also provided major elemental ratios of its surface [3] that can be used to infer large-scale differentiation processes and the thermal history of the planet. Mercury is known as being very reduced, with very low Fe-content and high S and alkali contents on its surface. Its bulk composition is therefore likely close to EH enstatite chondrites.

In order to elucidate the origin of the chemical diversity of Mercury's surface, we determined the melting properties of EH enstatite chondrites, at pressures between 1 bar and 3 GPa and oxygen fugacity of IW-3 to IW-5, using piston-cylinder experiments, combined with a previous study on EH4 melting at 1 bar [4]. We found that the presence of Ca-rich sulfide melts induces significant decrease of Ca-content in silicate melts at low pressure and low degree of melting (F). Also at pressures lower than 3 GPa, the SiO₂-content decreases with F, while it increases at 3 GPa. This is likely due to the chemical composition of the bulk silicate which has a (Mg+Fe+Ca)/Si ratio very close to 1 and to the change from incongruent to congruent melting of enstatite.

We then tested whether the various chemical compositions of Mercury's surface can result from mixing between two melting products of EH chondrites. We found that the majority of the geochemical provinces of Mercury's surface can be explained by mixing of two melts, with the exception of the High-Al plains that require an Al-rich source. Our findings indicate that Mercury's surface could have been produced by polybaric melting of a relatively primitive mantle.

[1] Zolotov M. Y. et al. (2013) *JGR*, 118, 138-146. [2] Solomon S. C. et al. (2011) *Planet Space Sci.*, 59, 1827-1828. [3] Weider et al. (2015) *EPSL*, 416, 109-120. [4] McCoy T. J. et al. (1999) *Meteoritics & Planet. Sci.*, 34, 735-746.